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Flood risk perceptions and the willingness to pay for flood insurance in the Veneto region of Italy

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ABSTRACT

The floodplain of the Veneto region (north-east Italy) is one of the most inhabited and economically competitive urban landscapes in Europe. Moreover, recent flood events have caused millions of Euros in damage across the region. Due to the combined influence of climate change and socio-economic development, flood impacts are expected to grow. Therefore, it is important for all flood-prone individuals to actively manage and limit flood risk through property-level flood risk management as part of an integrated flood risk management strategy. This is in line with the calls for wider community engagement in risk management in the Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals. Therefore, an online-survey of Veneto region residents was conducted asking questions regarding flood risk perceptions, preparedness, and preferences towards flood insurance via self-stated willingness to pay (WTP). Our analysis provides an initial indication that while flood risk knowledge is high, it may not be sufficient to encourage proactive risk management. From the WTP values provided people seem reluctant to buy insurance. However, many respondents expressed that a compulsory insurance system may be acceptable. In such a scheme the estimated insurance premium could fall to between €26 and €42 per year, as compared to, potentially, €800 under risk-based premiums, which falls within the majority of WTP estimates provided (€0-€250). Overall, we identify areas of future research that are critical for the better design of risk management policies, supporting the insurance companies in risk management, and for recommendations regarding property-level risk management.

1. Introduction

Across Europe, floods cause about one-third of the economic losses from natural hazards [1] with an expected annual loss of €4.2 billion [2]. Therefore, flood impacts are large today and are projected to increase in the future due to a combination of climate change and socio-economic development [2–4]. Therefore, there is a strong need to limit flood impacts. This need has led to a growing movement towards integrated flood risk management where all individuals threatened by flooding should play a role in limiting flood risk by implementing property-level risk management actions [5].

An active role for the residents of flood-prone areas is promoted because research has found that property-level risk management can mitigate the impacts of floods [6,93]. Property-level actions can be, broadly, divided into (i) those that physically limit flood impacts and (ii) those that transfer financial losses [7]. Physical measures consist of, for example, permanent water barriers, engineering work, emergency measures (e.g. sandbags) or the movement of personal goods to higher positions [8]. The representative instrument for transferring financial losses is insurance. Flood insurance has gathered much attention by governments [9] due to increasing global flood losses [10] and the ample evidence that insurance is more effective than *ex-post* disaster aid [11]. The successful use of insurance provides a rapid and useful alternative for aiding recovery to reduce potential long-run impacts [12,13], as compared to *ad-hoc* government compensation. However, while helping to provide financial security, flood insurance does not directly reduce the physical impacts of flooding. Unless, these insurance mechanisms are correctly designed to incentivise additional property-level risk management strategies [14–17] while promoting recovery.

Correctly designed insurance mechanisms can act as a risk management incentive because if a policyholder undertakes actions that limit potential impacts the premium should also fall. This requires that flood insurance premiums are risk-based, which means that premiums are altered in line with the risk faced. However, for flood insurance to provide this avenue for flood risk management, flood insurance must be purchased, and insurers must be willing to provide the policy.

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Therefore, it is important to understand the shape of the willingness to pay (WTP) distribution for insurance policies. This is because for a flood insurance market to be developed, there must be a sufficient degree of overlap between the premiums charged and what people are willing to pay.

Additionally, for an individual to employ property-level flood risk management strategies, they must have a sufficient level of knowledge to understand the threat they face. Therefore, it is also important to explore an individual's knowledge about flood risk in addition to their preferences and willingness to pay towards property-level flood risk management strategies [18,19]. In understanding how individuals prepare for flooding, the Protection Motivation Theory (PMT) has become a leading theory in explaining the uptake of protective actions [20–22]. The PMT frames decision making as the eventual result of two key elements: the threat appraisal, the degree to which someone feels threatened, and coping appraisals, someone's self-stated personal capacity to undertake protective actions. While it is debated which of these two factors is the most important overall for risk-reducing behaviour [20,21,23,24], both are required to engage in flood risk management [25].

Threat and coping appraisals reflect an individual's subjective understanding of the flooding threat faced. Subjective risk perceptions occur due to the range of local conditions [26] altering how an individual conceptualizes the threat [27] and their potential risk management strategies [28]. Therefore, given the role of the subjective understanding of flood impacts and experiences, it is critical to understand which local conditions are essential for determining action. Once these factors are understood, better flood risk management strategies can be designed.

The various factors that can influence this subjective understanding of flood risk originate from a variety of sources. One source is an individual's socio-economic condition as different socio-economic conditions expose people differently to disaster risk [29,30] and their ability to act [31–33]. The second source is an individual's psychological characteristics, for example, worry and previous experience. These factors can be useful predictors for an individual willing to take protective actions [23,24]. The third source is geographical attributes which can influence peoples' willingness to undertake protective actions. For instance, a positive correlation has been found with proximity to the source of the hazard due to the greater promise of the threat in daily life [18,23,34]. A final set of influencing factors is based on how the individual is integrated into society. An example is the trust of an individual in local flood risk management authorities given that flooding is a complex problem [35]. Similarly, trusted risk communication efforts can encourage proactive flood risk management [36]. Moreover, if an individual's neighbours undertake proactive flood risk management, they are also more likely to undertake a protective action as well [37]. These social interconnections are known as social capital, which is based on an individual's trust in their community or across different groups in society [38]. Social capital is a local concept, and these local interactions can create a degree of 'place attachment'. The concept of place attachment can explain the relationships the human has with the surrounding environment [39]. These bonds to both 'place' and 'people' can affect disaster preparedness and response in the wake of floods, as reported by Mishra et al. [40].

Overall, given the importance of local conditions and cultural contexts in determining whether an individual undertakes a protection action is required, we conducted an online survey in the Veneto area of North East Italy in order to better understand flood risk perceptions and the WTP for flood insurance. Understanding these factors is vital for supporting the development of flood insurance in Italy. With this in mind, our core research objectives are:

1) To explore the threat appraisal of individuals to identify the most likely important psychological, experiential and socio-economic variables have in this regard;
2) To explore the potential preparedness of Veneto region residents in the face of possible flood events;
3) To explore the preferences of flood insurance schemes and to what extent people are willing to pay for these products.

While exploratory in nature, our findings generate a research agenda that can provide insights and recommendations to improve overall flood risk management practices by suggesting directions for future research [41]. For instance, we suggest an initial research direction regarding the design of effective risk management policies through the active inclusion of social aspects into policy design. An example is that researching how bi-directional communication efforts can be designed as it may be essential in helping threatened individuals to understand the problem and co-create possible solutions by proactively participating in the decision-making process. This is because as argued by Baan and Klijn [42] "sustainable solutions can be found only when qualitative research on human values and perceptions is investigated".

2. Case study area

2.1. Veneto region physical geography and flood risk

Italy is particularly sensitive to flooding, as between 1990 and 2006 Italy suffered around €20bn of damage in total [43]. Moreover, this period was not exceptional, as Italy's history is marked by devastating flood disasters [44].

The Veneto region encompasses an area of 18400 km^2 of which the floodplain occupies about 55%. The floodplain was formed by the actions of the Po, Adige, Brenta, Piave, and Tagliamento rivers [45]. The floodplain of the Veneto region has a high level of human and landscape interactions [46,47]. Therefore, the region is an example of the consequences that such strong interaction might cause through the region's long history of flood disasters due to this human-nature interaction [48]. The Veneto region suffered significant floods in November 1966 [49] and 2010 (Fig. 1). The 2010 flood was one of the most severe floods recorded in the last 50 years. Between 31st October and 2nd November 2010, the region registered an average of 173 mm of rainfall with peaks of 540 mm [50]. This flood caused the displacement of 500,000 people and caused over a billion Euros of damage. Moreover, according to Sofia et al. [47], there has been an intensification of flood events since the early 20th century to 2010.

2.2. The flood insurance market in Italy

Insurance schemes across the globe develop based on the environmental and cultural contexts of the individual country, which produces a range of different insurance markets [53–55]. The consequence of the individualized development process for Italy is the absence of a well-developed flood insurance sector for private-property [56]. This is highlighted by the finding that in 2016 only 2.1% of the whole private-property insurance market was insured against flooding [57]. Moreover, the total coverage provided by the available insurance policies is also limited [57].

In response to this ill-development, the Italian government copes with flood occurrence by declaring a state of calamity or emergency (*stato di calamità* or *stato d'emergenza* respectively) depending on the subjects involved (Table S1, in the Appendix 1 of the supplementary material). Once a state of emergency has been declared, those affected can receive economic assistance from the government. Zampetti et al. [58] found that this has resulted in large government expenditures for financial aid, but found to be still insufficient to fully compensate the reported flood damage. While *ex-post* support can assist the recovery process for those affected by a flood, it also translates into people's lack of adoption of protective measures or insurance. This phenomenon is called charity hazard [59], in which altruism could play a negative role

Fig. 1. Veneto region study case and related provinces. Sampled municipalities are coloured in grey. On the right November 1996 [51] and November 2010 floods [52].

in people's flood risk management behaviour [60] and the development of natural hazard insurance markets.

3. Methods and data section

3.1. Survey description and sample characteristics

An important note regarding this dataset is that it is intended to be explorative in nature. Thus, several categories of variables have been considered (experiences, psychological, geographical and socio-economic factors) in order to establish initial connections with the key dependent variables: threat appraisal, flood preparedness, and the WTP for flood insurance. This is in order to identify the relationships that may be most productively investigated in future research, which in turn can be used to better design flood risk management strategies. The questionnaire produced data from closed-ended questions, which were coded for analysis. Additionally, qualitative answers (including any spontaneous additions by respondents) were also provided and were also categorized and then coded. A complete description of the variables used in this study is found in Table 1.

3.1.1. Sampling process

Our exploratory dataset was collected through a questionnaire linked to the online public portals of the Department of Land, Environment, Agriculture and Forestry website (University of Padova). The Department Director revised and approved the questionnaire, which was subsequently pre-tested with a sample of 30 people. The questionnaire was designed to be exploratory rather than to directly answer a single research question.

The questionnaire was accessible from late March until December 2017. The questionnaire was disseminated via social media across personal profiles, several environmental agencies, media press, private associations and municipalities. Concurrently, an email to the (relevant) Civil Protection Departments of Veneto region containing the survey was sent to aid the diffusion of the survey further. Finally, a hard copy was provided to Civil Protection Departments to help reach the elderly. Throughout the sampling process responses from Belluno were not sought out and were excluded from the sampling process. These potential respondents were excluded since the beginning of the data collection and sampling process because flood events in this mountainous landscape are of a very different origin and were not directly comparable with the other areas. The online questionnaire (unlike those distributed via the Civil Protection Departments) could not

Table 1
Variables description, unit of measurement, mean and standard deviation (SD) value.

Variable name	Variable type and unit of measurement (model)	Mean	SD
Panel A: Risk perception			
Threat appraisal (dependent variable)	Dummy (High = 1, otherwise = 0)	0.29	0.45
Likelihood of occurrence	Dummy (High = 1, otherwise = 0)	0.51	0.50
Flood cause	Dummy (Human > Climate = 1; otherwise = 0)	0.90	0.30
Flood risk knowledge	Dummy (High = 1, otherwise = 0)	0.37	0.48
Trust on flood risk management actions	Dummy (High = 1, otherwise = 0)	0.19	0.39
Place attachment	Dummy (High = 1, otherwise = 0)	0.73	0.44
Perceived preparedness (dependent variable)	Dummy (High = 1, otherwise = 0)	0.19	0.40
Panel B: Preparedness actions			
Active actions: seeking for information, sandbags, insurance policy, emergency kit, etc.	Dummy (High = 1, otherwise = 0)	0.75	0.43
None actions might help me	Dummy (High = 1, otherwise = 0)	0.06	0.24
None actions because I am not at risk	Dummy (High = 1, otherwise = 0)	0.08	0.27
None actions because it is Government task	Dummy (High = 1, otherwise = 0)	0.17	0.38
Panel C: Flood experience			
Direct experience	Dummy (yes = 1, otherwise = 0)	0.59	0.49
Direct experience with damage	Dummy (yes = 1, otherwise = 0)	0.12	0.33
Indirect experience with damage	Dummy (yes = 1, otherwise = 0)	0.57	0.49
Proximity to river	Dummy (≤500 m, otherwise = 0)	0.31	0.46
Panel D: Province			
Padova	Dummy (yes = 1, otherwise = 0)	0.32	0.46
Rovigo	Dummy (yes = 1, otherwise = 0)	0.07	0.25
Treviso	Dummy (yes = 1, otherwise = 0)	0.17	0.37
Venezia	Dummy (yes = 1, otherwise = 0)	0.16	0.37
Verona	Dummy (yes = 1, otherwise = 0)	0.08	0.27
Vicenza	Dummy (yes = 1, otherwise = 0)	0.21	0.40
Panel E: Socioeconomics			
Gender	Dummy (Female = 1, otherwise = 0)	0.41	0.49
Age	Category (≤30 = 1; 31–50 = 2; 51–65 = 3; 65+ = 4)	2.11	0.85
Education	Dummy (University and higher = 1, otherwise = 0)	0.52	0.55
Income	Dummy (High = 1, otherwise = 0)	0.40	0.49
Family members	Category (≤2 = 1; 3–4 = 2; 5+ = 3)	1.77	0.63
Employment	Category (Employed = 1 no employed = 2 retired = 3)	1.37	0.67
Panel F: Household characteristics			
Home ownership	Dummy (yes = 1; otherwise = 0)	0.65	0.48
Presence of underground	Dummy (yes = 1, otherwise = 0)	0.54	0.50
House surface (m^2)	Category (≤100 = 1, 101–149 = 2, 150+ = 3)	1.92	0.84
Panel G: Insurance			
Insurance coverage	Dummy (yes = 1, otherwise = 0)	0.23	0.42
Willingness to insure (imitation)[a]	Dummy (High = 1, otherwise = 0)	0.30	0.46
Willingness to insure (once flooded)[a]	Dummy (High = 1, otherwise = 0)	0.48	0.50
Willingness to pay[a]	Continuous (Euro)	272.45	773.54
Willingness to have National compulsory insurance only for people at risk	Dummy (High = 1, otherwise = 0)	0.57	0.50

[a] This question has been addressed only to individuals without any insurance coverage.

prevent some citizens from Belluno from answering due to the limits of the tools used. However, we gathered just 20 questionnaires completed from that province that were removed before futher data processing and analysis was conducted.

3.1.2. Sample composition

Fig. 1 shows the municipalities from which responses were collected. A total of 849 responses were collected and out of the 512 municipalities (excluding Belluno province, which was not actively sampled), 236 were covered by the respondents. The majority of respondents are originated from Padua (31%), while the smallest contributing area was Rovigo (7%).[1]

In terms of sample composition, self-reported males account for 58% of responses and self-reported females for 41%. The average age is 43 years old. The majority of respondents reported as having a high school diploma (38%), 35% of respondents reported having a university degree, and 13% of respondents have a higher degree. The majority of respondents are employed (71%), while the remaining respondents tend to be unemployed or retired. However, only 40% feel comfortable with their income. Regarding family composition, the average household consisted of 3 members. Concerning personal familiarity with flood events, 58% of respondents have experienced a flood, 12% have suffered damage from a flood, and 56% know someone that experienced financial losses from flooding. Homeowners are 63% of the sample.

3.1.3. Key questions

In terms of the key dependent variables, threat appraisal was calculated by averaging the responses regarding the feeling of danger for one's house and one's physical safety. The flood preparedness variable was gathered by asking people about their personal feeling of readiness, providing a subjective viewpoint. The insurance WTP question was an open-ended question where the respondent was invited to provide how much they would be willing to pay for an annual flood insurance policy. They were asked to considering a limited coverage for the building (excluding furniture), with a coverage of 50% of the value of the building and a deductible of 5% of damage suffered. This question was only asked to those who stated to not have an insurance policy in place. Therefore, studying these WTP answers can help us better understand barriers to the development of flood insurance in Italy. That future research can in turn address.

3.2. Statistical methods

The statistical analyses carried out have the purpose of finding

[1] The sample size had adequate statistical power to detect significant statistical findings, which can be used to guide future research.

potential relations and correlation directions rather causal relationships. This is due to the nature of the sample (self-selected) where establishing causal relationships is not possible. Therefore, our study identified directions for future research that can further employ experimental statistical techniques.

To study threat appraisal and preparedness behaviour Logit models were employed. These logit models were selected as the dependent variables were dichotomous outcomes which we related to different sets of explanatory variables. The sets of explanatory variables are personal experiences, psychological variables, geographical and socio-economic factors. In order to determine the variables that are the most likely to be important for future research in the Veneto region, a variable reduction approach is employed to help identify which variables may be the most important for the respondents. Therefore, the logit model is first estimated with all the variables listed in Table 1. Then in a stepwise fashion, the non-significant variables (at the 10% level) are removed from the complete model output. The model is then run again until no such variables are found. This approach is similar to that used in Bubeck and Thieken [61] for instance. The tests used to establish significance at each stage of the stepwise process were t-tests. For each model, the estimate (β), standard errors (S.E.), significant values (*p < 0.1, **p < 0.05, ***p < 0.01), and odds-ratio have been shown.

While logit models were used for threat appraisal and preparedness, for the willingness to pay we ran a Heckman selection model, also called a 'generalized Tobit model' [62,63]. This is because about 37% of respondents asked this question provided a zero WTP or fail to answer. However, the model did not display sufficient statistical quality. Therefore, a qualitative analysis has been carried out due to this underlying limitation.

4. Results and discussion

As noted in Section 3, the results presented in this section should be treated and exploratory in nature. This is because of the complex set of behaviours and institutional arrangements that govern the employment of property-level flood risk management strategies. Therefore, the findings presented below show an initial understanding of property-level flood risk management in the Veneto region of Italy. Thereby forming a base upon which future research can act.

4.1. Threat appraisal

The overall threat appraisal of the respondents seems to be quite low, with a mean value of 0.29 (see Table 1) and respondents seem to be slightly more afraid for their property than for themselves where floods are concerned. The variables that are associated with a higher individual perception of flooding or threat appraisal, after the stepwise variable reduction process, are shown in Table 2.

The associations presented in Table 2 indicate that a higher feeling of danger is positively associated with flood risk knowledge and a belief that floods have a high likelihood of occurrence. These possible connections are not surprising as they are directly related to concern. Similarly, respondents living close to major rivers were also associated with a higher threat appraisal. Another potential associated identified is that respondents living in the province of Rovigo feel a higher level of danger for even if they have not experienced recent catastrophic flood events. It is probable that people have a good memory of past river overflows and they might be afraid that something of that kind might happen again due to the worsened climatic conditions and anthropogenic changes (i.e. land subsidence) [64–68]. Finally, homeownership was also positively associated with higher threat appraisal. Homeowners face higher possible losses during a flood, as compared to tenants. Overall, we take these results to indicate that the Veneto region, overall, may have a moderate risk awareness and as such threat appraisal (as a combination of worry, knowledge and expected occurrence), and the more people are aware, the larger the potential demand to reduce such risk [69].

Table 2
Logit regression: the most likely important determinants of threat appraisal in the Veneto region of Italy (n = 845).

Explanatory variable	β	S.E.	Odds Ratio
Likelihood of occurrence	2.382***	0.290	10.824
Flood risk knowledge	0.459**	0.224	1.583
Trust	−0.727**	0.327	0.483
Direct experience with damage	0.991***	0.311	2.693
Indirect experience with damage	0.428*	0.243	1.534
Proximity to river	0.609**	0.243	1.838
Homeownership	0.538*	0.330	1.713
Rovigo	1.210***	0.445	3.354
Constant	−3.839***	0.463	0.022
Log L	496.485		
Cox and Snell pseudo R^2	0.242		
Nagelkerke pseudo R^2	0.348		
% of correctly classified cases	78.2		

However, while the psychological, geographical and economic variables, which survived the stepwise iteration process are positively associated with respondents' threat appraisal trust was not. Trust forms an essential element of social capital which may indeed display a negative relationship with risk perceptions as was found in a study from Austria [70]. Our respondents indicated an overall lack of trust with the government regarding the management of flood events. Furthermore, about 35% of respondents added that the finances for flood risk management were poorly managed combined with a perceived believe that flooding was not a high priority for the management authorities (27%). Therefore, when combined with our initial indications regarding threat appraisal it appears that our respondents based their feelings on a fragile sense of protection provided by the institutions meant to manage flooding. This lack of trust has been found in several Italian case studies [71,72]. However, Kuhlicke et al. [73] find that in Italy when there is a high level of trust in voluntary organisations, municipalities and the Civil Protection, i.e. the institutions involved in flood risk management, individuals can be encouraged to decrease their level of vulnerability to flooding. Direct and indirect experiences were positively associated with threat appraisal. The potential correlation between a higher threat appraisal and friends and neighbours flood damage experience is potentially important for two reasons: the first because the social relationships in the area are also characterized by a high level of trust and the share of environmental concern and the second because it may help in prioritizing the actions in case of a possible future scenario. Therefore, overall, while our exploratory findings show a moderate level of risk awareness, we see that it may be counteracted by a low level of trust in the overarching flood risk management framework. This is an area of future research concerning the trade-off between trust and risk awareness or threat appraisal and how it may be counteracted.

4.2. Flood preparedness

The average respondent's self-stated preparedness to deal with a flood is relatively low (0.19, Table 1). Approximately 71% of respondents state that they have already taken or will undertake in the next months some attempt to limit flood damage (e.g. purchasing emergency protection measures). Additionally, nearly 16% of respondents stated that they do not intend to take any preparedness actions. Primarily, this is because of their belief that it is the government's responsibility to protect them from flooding. The remaining 6% display a more fatalistic perception of flooding in that acting at the individual level is not effective, displaying a sense of powerless.

Similar to the previous section, an exploratory analysis of the correlations between various factors and preparedness was conducted and presented in Table 3. Table 3 indicates a potentially positive correlation

Table 3
Logit regression: the most likely important determinants of personal flood preparedness in the Veneto region of Italy (n = 831).

Explanatory variable	β	S.E.	Odds Ratio
Threat appraisal	−0.672**	0.296	0.511
Flood risk knowledge	1.976***	0.237	7.212
Trust	0.775***	0.265	2.170
Direct experience	0.800***	0.249	2.226
Proximity to river	−0.435*	0.258	0.647
Padua	−0.888**	0.342	0.411
Venice	−0.693*	0.362	0.500
Gender	−1.061***	0.258	0.346
Place attachment	0.875***	0.294	2.399
Constant	−2.960***	0.442	0.052
Log L	540.530		
Cox and Snell pseudo R^2	0.236		
Nagelkerke pseudo R^2	0.370		
% of correctly classified cases	83.5		

between flood risk knowledge and perceived preparedness. Additionally, when combined with the results presented in Table 2 it appears that when perceived preparedness is high, they feel less the danger because of confidence in their capacities to cope with them (hence the negative correlation with the threat appraisal). However, this result might seem counterintuitive in light of the empirical literature (e.g. Refs. [31,74,75]) which argues that, for example, negative emotions, such as worry of flooding can encourage a person in taking preparatory measures [76]). However, Raaijmakers et al. [69] debate that a better-prepared society will worry less about the eventual flood similar to how increases in social capital may strengthen a respondent's perception that they can undertake preparation actions at the expense of lower risk perceptions as flooding is seen as less of a threat [70]. Direct experience helps to motivate people to prepare for future floods. Unexpectedly, suffering an economic loss from a flood does not the same potential influence; rather it appears that the experience itself is sufficient. The presence of a nearby river is associated with a lower level of preparedness. An explanation of this is that these residents are less directly influenced by a possible flood and hence may overestimate their actual level of preparedness.

In the context of authorities, again trust seems to be predictive of flood preparation. However, this is contrary respect to threat appraisal. Cisternas et al. [77] find that this is a situation in which trust does not favour people taking responsibilities for their flood preparedness.

We find that gender is correlated with self-perceived preparedness levels as we find a tendency for males to be associated with a higher preparedness level. In Italy, in line with the finding highlighted by Roder et al. [78], the position of women in the job-market sector results in women displaying one of the lowest labour market participation rates as compared to other developed countries [79]. Moreover, women's lower perceived preparedness is also found in other studies regarding Northern Italy (see, e.g. Refs. [80–82]). For example, De Marchi et al. [80] argue that men have a higher perceived preparedness because of their greater involvement in local associations and social networks.

Others socio-economic variables failed to have significant direct effects on flood preparedness intentions in addition to building characteristics. The role of place attachment and flood preparedness has been discussed by Mishra et al. [40]. Those communities showing the strongest bonds have more capacity to be prepared for risky situations. We find evidence supporting this argument via our study of place attachment which indicates a positive correlation with perceived preparedness. This, in turn, highlights the potential importance of social capital regarding how individuals act in the face of flooding.

However, overall the previous section indicated a potentially moderate level of risk awareness, but this section indicates a low level of overall preparedness. Therefore, future research on how to strengthen the link between awareness and action is required in order to convert intentions into tangible proactive action.

4.3. Willingness to insure and to pay for flood insurance

Section 2 noted that the flood insurance penetration rate in Italy is very low. However, over 18% of the sample stated to have flood insurance coverage, which is significantly above the average penetration rate in the Italian flood insurance market. This value may indicate an increased interest in insurance or a false belief that their home insurance covers damage caused by flooding [83]. This uncertainty is supported by the fact that about 5% of respondents did not know if their house was insured or not. This may indicate a low level of flood risk financial knowledge. Only property owners and female respondents were found to be associated with a higher likelihood of buying an insurance policy. These were the only two variables from the logit model which were found to be significant at the standard levels.

On analysing the reasons behind those who are not protected by insurance (multiple answers were allowed), 23% of respondents stated that they were interested, but the cost was not convenient. About one-fifth of respondents stated that they to do not know of the existence of these products (which holds across education levels). Similar to the results regarding threat appraisal, 17% of respondents did not consider the purchase of flood insurance because they do not feel to be at risk of flooding. Moreover, 14% of respondents expect financial assistance from the government in case of flood damage, indicating the presence of charity hazard as this was their reasoning for not buying flood insurance. Finally, the remaining 13% stated that they did not believe in the insurance system overall and hence did not buy insurance. Additionally, while the Italian national budget has been able to cope with the costs of post-catastrophe relief activities, this will become a larger burden in the future as flood risk grows. Moreover, according to Zampetti et al. [58], the official costs of damages presented by the municipalities in the period 2009–2012, amounts to €2.2 billion, almost three times the resources made available.

Our data, therefore, indicate a combination of responses which is potentially problematic for the Italian flood insurance market as they show how the demand for private insurance coverage is limited. This problem is further compounded by the reliance on inadequate central government compensation creates a growing recovery financing gap. Overall, there appear to be significant hurdles to overcome for the successful development of an insurance market.

A potential avenue for overcoming these hurdles is through increased social interaction. This is because 19% of respondents considered investing in insurance if they knew some friends, neighbourhood or close people to have an insurance policy. As found by McGuire [37,84], insurance purchase is strongly influenced by social norms and societal expectations. Moreover, it should be noted that about 57% of respondents support the idea to have national insurance for the communities that live in risky areas. In this context, reducing the degree of government compensation would lessen the influence of charity hazard, which in turn increases the opportunity cost of not being insured. This opportunity could result in the long run translate into increased demand for flood insurance and permit people to get protected from common floods and leave the government to deal with the extreme ones. Developing a public-private partnership in this direction may allow both sets of actors to provide sufficient compensation after a flood to promote a sustainable recovery [85].

Section 3 noted that WTP was included in the survey via an open-ended and self-stated continuous value. Table 4 describes the frequency-bins of the values provided by the people without any insurance coverage, providing a first attempt at identifying possible avenues for researching solutions to the low rates of insurance coverage.

Among those interested in undertaking such a policy, most respondents would at most spend between €0 and €250 per year. However, the high rate of missing answers and some zero WTP values

Table 4
Open-ended WTP (in Euros per year) aggregated into three classes for flood insurance in the Veneto region of Italy.

Bid offered	Frequency	%
0	37	8.0
> 0 - 250	309	67.0
> 250 - 500	46	10.0
> 500	69	15.0
Total	461	100

Missing answers, n = 186.

might indicate a misunderstanding in the complex task of determining what they would be willing to pay. A modest percentage of respondents (16%) stated that they would spend €500 annually reaching, in some cases, up to €1000. Among the latter respondents, 24 respondents have a WTP higher than 5% of the average regional annual income,[2] which could be considered unaffordable.

An additional source of qualitative comparison would be towards the potential premiums charged. Premiums are estimated according to the data and methods presented in Appendix 2, in the supplementary material. The data presented in Appendix 2 indicates that risk-based insurance premiums could be over €800 a year (about 4% of the average regional annual income). This is due to a combination of high flood risk and relatively low levels of flood protection. Flood protection infrastructure is estimated to be designed against the 1/60 year return period [86]. The risk-based premium estimate with the current protection standard is clearly far outside of what households are willing to pay. This finding holds if protection standards are doubled as the premiums fall to over €500 a year. Increasing the protection standards to a 1/250-year protection standard would lower premiums to about €250 a year. This increase in protection standards would render premiums within the willingness to pay range for about 25% of respondents. Therefore, without an increased understanding of the benefits provided by possessing sufficient insurance, it appears very difficult to establish an insurance market based on risk-based premiums by merely increasing flood protection. Our data provides this indication by noting only 23% of those not buying insurance stated to do so because of the size of the premium.

4.4. Implications for future research to improve flood risk management

From the exploratory results presented in Section 4.1–4.3, there are several future research directions which that already been identified. While these identified research directions can produce useful insights for flood risk management both inside the Veneto region of Italy and beyond there are also additional research directions drawn from a more holistic understanding of our exploratory results.

From the qualitative analysis of the WTP for flood insurance and related statements, the respondents appear reluctant to purchase flood insurance coverage. These exploratory findings are problematic for insurers because flood risk tends to be geographically clustered, limiting the potential for geographical diversification, and result in large numbers of claims in a short period [87]. This can result in primary insurers having difficulty in insuring flood risk at an affordable rate, which may become more difficult in the future [88]. This is unless there are suitable mechanisms in place to support them [89]. A possible mechanism identified through the exploratory survey was national compulsory insurance for flood-threatened communities. About 57% of respondents supported the concept. Moreover, such schemes can involve a strange of stakeholders acting in concert. This style of multi-sector partnership is often argued to help develop sustainable flood insurance sectors [89]. Assuming that flood insurance was made compulsory for all households in the Veneto region, the estimated insurance premium (see Appendix 2 in the supplementary information) falls to between €26 and €40 per year. This value is within the WTP range of 92% of the responses given making the premium more likely to be acceptable. However, structuring flood insurance like this would remove the risk signalling ability of flood insurance, lowering the overall risk management potential. Moreover, in order to prevent such cheap insurance premiums acting as a subsidy for further developing flood-prone areas, additional spatial planning or enforced flood-proofing will be required. These problems are potentially compounded by a lack of trust. Linnerooth-Bayer et al. [90] show that low trust in key institutions and lack of a proper market in the country raise the question whether the institutional context in Italy is sufficiently mature for such schemes to operate. The respondents sampled did express a rather low level of trust in both insurers and governmental flood risk managers. Therefore, several research directions are opened from this avenue. The first is to investigate how a compulsory flood insurance scheme would be structured and the resulting premiums and how tasks are divided across stakeholders. A second direction regards how the governance structures can be arranged such that the level of trust that local residents have in the developed system can be improved. For instance, while Italy is quite far from an adequate flood risk insurance system the government might consider formalizing disaster compensation to limit the occurrence of charity hazard. This could be similar to how Unterberger et al. [91] study an increasing formalisation of the Austrian Catastrophe Fund.

Moreover, while future research on developing a compulsory insurance scheme to promote sufficient flood insurance coverage can bring several advantages to flood risk management; the exploratory survey results also indicated a, potentially, general disregard of insurance products. For instance, about 37% of respondents did not answer the WTP question. While it is appreciated that this is a sensitive topic the rate of missing answers was much higher than the other survey questions regarding property-level risk management strategies. This limitation suggests that future research into the exploration of the reasons behind the lack of interest is required. For instance, if a general mistrust in the insurance companies, it arises from the type of questions proposed or the fear of future compulsory insurance scheme (for instance). The development of this knowledge would allow researchers, policymakers, and practitioners to be in a better position to collect the information required to develop a suitable enabling environment for property-level risk management strategies to be developed. Therefore, this requires deeper research to extract the relevant behaviour behind these intentions.

Additionally, from a qualitative analysis of the results presented in Section 4.1-4.3, there may be a high overall understanding of the flood risk faced in the Veneto region. However, this doesn't translate into proactive property-level flood risk management. Therefore, our analysis hints at hurdles to proactive risk management. It is possible that risk communication campaigns could be directed on inform communities on what they can do, the existence of insurance to normalise insurance coverage, as well as the relative threat posed by flooding to mitigate availability biases or other heuristics. Our exploratory results indicate that such activities may be successful as respondents with a better-developed flood-knowledge displayed positive responses across all areas of this study. Consequential, we believe that these initial results indicate that a flood risk-oriented communication campaign may bring positive benefits regarding flood insurance but also property-level flood risk management strategies as a whole. This is because the logit models suggested that the social networks, identified in this research by trust, place attachment and indirect experience knowledge, are promising factors shaping flood risk knowledge, as also evidenced by Table S2 in the Appendix 1 of the Supplementary material. Furthermore, this implies that tailored communication strategies are required if they are to foster individual proactive actions [92]. This, in turn, implies that

[2] Mean annual income 2016 retrieved on June 5th, 2018 from Ministry of Finance open data website: Available at: https://bit.ly/2NBAv9i.

future research is required to establish how risk communication can be correctly tailored. Moreover, this research should also be conducted in such a way that the success of risk communication strategies can be evaluated, as this is a current gap in the literature that must be addressed.

5. Conclusions

Under the lens of the increasing flood impacts worldwide, there is a growing need for well-developed and considered policy interventions. Among these interventions, public policy needs to focus their attention towards increasing the understanding of natural hazard risks to increase their awareness and risk management actions. In line with this, the role of insurance for flood risk management has gained much attention as an effective tool that could promote a greater degree of forward-looking disaster risk management in places where this instrument is still underemployed.

To address this task, a northern Italian region, Veneto, was chosen as the study area. The Veneto region is a highly anthropogenic landscape that is prone to flooding creating a large economic burden. An online survey was conducted asking the respondents three main topics: flood risk perception, the flooding preparedness actions, and flood insurance preferences. An exploratory statistical and qualitative analysis of this data was conducted in order to identify directions for future research that can lead to improvements in flood risk management across Italy through a greater understanding of individual-level perspectives and respondents.

This exploratory research argues that there are cognitive, social and practical rationales behind the respondent's answers, whereas the influence of personal characteristics on their actions and beliefs was limited. The most important variable connected to threat appraisal and perceived preparedness was flooding knowledge, underlying that people do not disregard the suitable information. When risk knowledge is high, there is also a greater opportunity to include flood-prone people in the flood risk decision-making process. Proactive involvement of the community in flood risk management can also aid in transferring this knowledge into the wider community. However, the diffusion of such information would require a sufficient level of trust across and within stakeholder communities. Our results hint at the potential trade-off between threat appraisal and perceived preparedness if trust grows which can complicate this process. An aspect of this may be because of negative public sentiment towards the current flood risk managers that our data indicates. Addressing the sources of this negative public sentiment could address this trade-off. The role that the media plays is fundamental in this regard for amplifying or alter the understanding of flood risk and how the socio-political sphere acts. This will require future research.

Regarding the acceptability of flood insurance has evidenced that people seem reluctant to buy flood insurance, being discouraged by the cost or simply because they did not know the existence or need for such products. The average amount people have been willing to pay was up to €250, which is likely far below the premiums charged if they are risk-based but would be sufficient for compulsory solidarity-based insurance scheme. Therefore, research into the development of a functioning flood insurance market is required. This research can relate to the role of increased collaboration between the government and private insurers so that their actions are commentary rather than overlapping. Moreover, such joint activity can also leverage both stakeholders' knowledge on how to successfully communicate information and the need to be insured and what can be expected. Risk communication and education strategies should be initially targeted on developing support and increased understanding of the role that flood insurance could play in helping to manage the impacts of flooding.

Overall, the topics mentioned above stand to be very fruitful areas of future research that when taken together can lead to a more productive risk management environment both at the risk manager level and at the property level.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijdrr.2019.101172.

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